Evaluating Security, Privacy and Usability Features of QR Code Readers

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Abstract: The widespread of smartphones with advanced capabilities has motivated developers to design new mobile applications that are used as barcode scanners. Although several barcode readers are available, they still have security and privacy limitations. In this paper, we first present a comprehensive and systematic review of barcode reader applications by analyzing their security, privacy and usability features. We categorize these apps into four groups depending on their properties: URLs security, Crypto-based security, Popular applications, and Save-privacy. We also highlight their weaknesses and present design recommendations for usable, secure and privacy-guaranteed scanner applications. Based on our recommendations, we have developed BarSec Driod a proof-of-concept secure barcode reader Android app that exploits some features of other applications and at the same time overcomes their limitations. We have performed a user usability and security survey, on BarSec Driod and two other popular QR code readers, KasperSky and QR Droid Private. The results show that BarSec Driod is easy to use, satisfies the expectations of the users and is secure. Moreover, we have observed that following the design tips, user's security awareness and usability increase.

1 INTRODUCTION

Barcodes are low cost and easy-to-process data holders that in the last decades have become very popular and widely used. Barcodes can hold products' identification numbers, contact information, Uniform Resource Locators (URLs) and maps' coordinates (Focardi et al., 2018b). A barcode scanner is an optical machine that has imaging and processing capabilities (camera and processor), and is used to extract data from a barcode image (Denso Wave, 2017). The widespread of smartphone devices with high resolution cameras has motivated developers to create mobile applications that can decode barcode images, and can provide additional features such as: sharing contacts, messages and URLs. Quick Response (QR) codes are the most popular barcode types, with the highest data capacity.

Barcodes can represent a source of attacks that infect scanner devices with viruses and malware. Attackers may trigger vulnerabilities in the scanner's software, which can result in taking full control of the user's device and resources. These applications can violate users' privacy by accessing their private information (Focardi et al., 2018b).

Multiple studies were dedicated to address QR codes threats and solutions, while the practical side needs more analysis (Focardi et al., 2018b; Yao and Shin, 2013). Hundreds of barcode scanners are available for smartphone devices, some of them claim of being "secure" or "privacy friendly" (Dudheria, 2017; Google Inc, 2018). These applications need to be investigated and evaluated from security, usability and privacy perspectives. In this study, we present a comprehensive review of barcode scanner applications. We analyze the features of barcode readers, classify them into groups and highlight their limitations. Then, we present a set of design tips and recommendations for usable, secure and privacy-guaranteed reader application. Based on our recommendations, we have implemented BarSec Driod, a proof-of-concept Android application that exploits some features of other applications and at the same time overcomes their limitations. We have performed a user usability and security survey on BarSec Driod and two other popular QR code readers: KasperSky and QR Droid Private (KasperSky Lab, 2018; DroidLa, 2016). Our results show that following the design tips user's security awareness and usability increase.

Paper Structure: The rest of this study is organized as follows: Section 2 presents a brief summary of the related work. Section 3 explores QR code reader applications and classifies them based on their features. In Section 4 we present our design tips and recommendations for secure, usable and privacy-friendly

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QR code readers, then we present BarSec Driod, our recommended reader application. Section 5 explores the users' experiment and results of usability and security. Finally, in Section 6 we present the conclusion and future work.

2 RELATED WORK

In this section we recall the studies that evaluate some of the available QR code readers. However, w.r.t. our work, these studies take into consideration a limited number of applications (we have checked 28 of them), and none of them focuses on all the possible features, i.e., security, privacy and usability.

The study of (Dudheria, 2017) explores the available Android secure QR code readers, highlights their security properties and evaluates their capabilities in detecting malicious QR codes. According to the conducted analysis, many QR code readers claim to be secure scanners, however, they do not provide the basic security aspects and require enhancements. The study addresses the potential weaknesses and limitations of secure scanners applications, and provides recommendations to improve the security level. However, this analysis does not take into consideration the usability of barcode scanners.

The study of (Yao and Shin, 2013) explores the security capabilities for the 31 most popular QR code Android readers. Only 2 out of 31 applications have security warning capabilities, but extended experiments show that the threat detection mechanisms for phishing and malware attacks are very weak. Thus, the researchers propose a new QR code reader called SafeQR, which depends on two existing security APIs: Google safe browsing and phishtank (Google, site; Phishtank, site). However, the authors do not give any empirical evidence that the scanner is able to enhance the detection rates of malicious URLs. Moreover, the study does not take into consideration QR codes' offline threats such as SQL and command injections, privacy and usability features.

In (Krombholz et al., 2015) the authors present a comprehensive analysis of QR code security and privacy issues. The obtained results show that most of reader applications cannot detect malicious URLs. In addition, these applications violate the users' privacy, by getting extra permissions and accessing users' personal information. The study presents design recommendations for usable and secure reader applications, and proposes a prototype that employs Base64 digital signatures and URL checking. Results show that following the design recommendations can effectively protect users from malicious QR codes. However, the study is limited to 12 applications and it neither discusses the size and time overhead of applying digital signature protection, nor the implemented algorithms.

3 QR CODE READERS

Our analysis includes 28 reader applications that are popular or claim to provide security and privacy features.

Table 1 shows the details of the tested applications, such as: app developer, current version, number of installs from Google Play (Google Inc, 2018), category, rate (a 5 point scale users' evaluation of an application from Google Play), 1D/2D (ability of the reader to read general one dimensional (1D)/ two dimensional (2D) barcodes or only QR codes), and format (the reader displays the barcode type it has identified, e.g., QR code, etc.).

3.1 URLs Security Applications

Online protection includes checking URLs that are encoded inside QR codes, which can be used to launch phishing, malware and XSS attacks. The protection technique is simple and aims at alerting users about malicious links.

G Data QR code scanner (G Data Software AG, 2018) is a simple, free Android application, designed for QR code protection. This app checks the encoded URLs, in order to detect phishing and malicious links, it retrieves the full destination web address, even if it was embedded as a shortened URL (Dudheria, 2017).

KasperSky QR Scanner is a free app that validates the QR code links against malware and phishing Web pages (KasperSky Lab, 2018). The main limitation of KasperSky QR Scanner is that it opens URLs, detected as safe, directly in the browser without asking for user confirmation (Dudheria, 2017).

The Norton Snap QR code scanner (Norton-Mobile, 2016) alerts users against unsafe/untrusted URLs, shows the full expansion of the website address and blocks the malicious online content before being loaded on the user's browser.

Barcode Reader for CM browser (Browser Extension, 2018) is a lightweight QR code scanner that requires CM browser and automatically opens URLs. The CM browser performs the security protection that includes: Advertising blocker, malicious Web pages checking and download protection.

TeaCapps (TeaCapps, 2018) barcode scanner offers URL checking by using Chrome Custom Tabs, which employs Google Safe Browsing technology

Table 1: Details of tested QR Code readers.

App Developer	Version	Installs	Category	Rate	1D/2D	Format
(G Data Software AG, 2018)	1.0.2.0643c6ef	10K+	URLs	3.3	QR	
(KasperSky Lab, 2018)	1.2.4.51	1M+	URLs	4.4	QR	
(NortonMobile, 2016)	2.0.0.71	1M+	URLs	4.2	✓	
(Trend Micro, 2018)	1.0.0	10K+	URLs	4.8	✓	
(FANSec Lab Apps, 2018)	1.1	10+	URLs	5	✓	
(Madiff Net, 2017)	1.2	100+	Crypto	5	✓	
(Dennings, 2018)	1.0.17	1K+	URLs	4.1	✓	[a]
(KidControl Dev, 2018)	1.0	5K+	URLs	4.4	✓	✓
(DroidLa, 2016)	7.0.4	50M+	Crypto	4.2	✓	
(Tengler, D., 2018)	Free[b]	100+	Crypto	5	QR	
(Avira, 2018)	2.5.0	100K+	URLs	4.3	✓	✓
(Browser Extension, 2018)	1.0.0	100K+	URLs	4.3	QR	
(SECUSO Research Group, 2016)	1.6.1	10K+	Save-Privacy	4.4	✓	✓
(X and C Hi-Tech Inc, 2016)	2.4.3	500+	URLs	4.1	✓	
(iTechSol, 2018)	1.1	5+	URLs		✓	
(Red Dodo, 2014)	1.03	500K+	Save-Privacy	3.8	✓	✓
(Tokoware, 2016)	1.1.7	5K+	Save-Privacy	4.2	✓	
(FancyApp, 2018)	2.1.6	5M+	Save-Privacy	4.5	✓	
(TeaCapps, 2018)	1.3.1-L	1M+	URLs	4.6	✓	✓
(Ecrubit Consultancy Service, 2018)	1.0.2	1+	Crypto		✓	
(Application4u, 2018)	1.7.6	10M+	Save-Privacy	4.7	✓	
(Scan, 2016)	2.33	50M+	Save-Privacy	4	✓	
(ZXing Team, 2017)	Varies with device	100M+	Popular	4.1	✓	✓
(Geeks.Lab.2015, 2018)	1.2.91	10M+	Popular	4.6	✓	✓
(Gamma Play, 2018)	Varies with device	50M+	Popular	4.4	✓	
(Barcode Scanner, 2018)	1.25	5M+	Popular	4.4	✓	✓
(EZ to Use, 2018)	0.92	10M+	Popular	4.6	✓	
(I-Plex Technology, 2018)	1.0.5	1K+	Crypto	5	✓	

[a] Always display QR code; [b] Free version to test functionality.

(Google, site). Table 2 presents a comparison of barcode scanners that provide security by checking QR codes' online contents (URLs).

The main limitation of these apps is that URL-checking readers can protect users from malicious URLs only, while other offline attacks such as SQL and command injections can still be performed without detection. In addition, these applications require Internet connection to check URLs. Note that in this work, we evaluate the applications' features, not the database/model that checks the URL (e.g., Google Safe Browsing, etc.).

3.2 Crypto-based Security Applications

Cryptographic techniques can be used to encrypt, sign and control the access to QR code contents. Choosing the suitable algorithm, key size and structure are discussed in multiple studies (European Union Agency for Network and Information Security (ENISA), 2014; Focardi et al., 2018a), but the key factor on barcode usability is the size overhead (Focardi et al., 2018b). However, there are few applications that offer generating and reading cryptographic QR codes.

Madiff Net (Madiff Net, 2017) scanner application offers reading and creating password-protected QR codes, and the contents are encrypted using a shared password-based key between the generator and the barcode reader. The application is free, contains advertisements and available with three languages: English, Vietnamese and Chinese. As a limitation, we highlight that being the algorithm unavailable we cannot evaluate its strength.

QR Droid Private (DroidLa, 2016) is a full-featured and multi-language application, which offers reading and creating QR codes. The application supports URL shortening, QR code sharing and contents encryption. QR Droid is well adopted and available in 29 languages. The app employs the Data Encryption Standard (DES) algorithm with 56 bits key length which is considered weak and breakable.

Crypto Message (Tengler, D., 2018) is a security application that offers encrypting any type of

Table 2: Barcode scanners that check URLs contained inside QR codes.

App Developer	Check URL	Display URL	Get full URL	Direct Open	URL checking technique
(G Data Software AG, 2018)	✓	✓	✓		N/A
(KasperSky Lab, 2018)	✓			✓[a]	KasperSky Virusdesk
(NortonMobile, 2016)	✓	✓	✓	✓[a]	Norton Safe Web
(Trend Micro, 2018)	✓	✓			N/A
(FANSec Lab Apps, 2018)	✓	✓			N/A
(Dennings, 2018)	✓	✓			Google Safe Browsing
(KidControl Dev, 2018)	✓	✓			N/A
(Avira, 2018)	✓	✓			N/A
(Browser Extension, 2018)	✓			✓	CM browser
(TeaCapps, 2018)	✓	✓			Google Safe Browsing
(iTechSol, 2018)	✓	✓			N/A
(X and C Hi-Tech Inc, 2016)	✓			✓[a]	N/A

[a] Open URL directly if it is safe.

text message, and allows encoding ciphertexts in QR codes. Advanced Encryption Standard (AES) is available with four modes: Electronic Codebook (ECB), Cipher Block Chaining (CBC), Counter (CTR), and Output Feedback (OFB) modes. Note that, the embedded scanner cannot decode ordinary QR codes (generated by other applications). Crypto Message usage is non-straightforward and assumes the knowledge of some basic cryptographic concepts.

EC QR (Ecrubit Consultancy Service, 2018) is a QR code reader and generator application. The encryption algorithm, the key size and the structure of this app are not available and cannot be evaluated.

Observe that, all the above mentioned applications have some limitations: 1) They assume no standard way of encoding cryptographic data in QR codes, i.e., each application uses its own structure. Thus, in order to decode a crypto-barcode, the user will need to use the same generating application, while, on the other hand, the study of (Focardi et al., 2018b) proposes the use of the standard JavaScript Object Notation (JSON) as a general structure to be used with crypto-QR codes. 2) All these applications adopt weak cryptographic mechanisms such as: DES and AES-ECB. 3) These applications employ base64 and hexadecimal strings to represent ciphertexts, which leads to size overhead.

The password-protected QR codes achieve confidentiality and access control, and only authorized users (who have the password) can retrieve the encoded data. However, encrypting the contents is not enough to protect users who scan the QR code, since even encrypted data may contain malicious links or offline attacks. Generator authentication, data integrity and non-repudiation can be useful in protecting the users, and can be achieved using digital signatures (Focardi et al., 2018b). Table 3 presents a summary of crypto-based QR code scanners and it includes the app developer, encryption, digital signature (DS), algorithm (Alg), Key length (KL), encoding scheme (EncS) and structure (Str).

3.3 Popular Applications

In this section we present popular QR code reader applications that have been downloaded by more than 1 million users (see Figure 1).

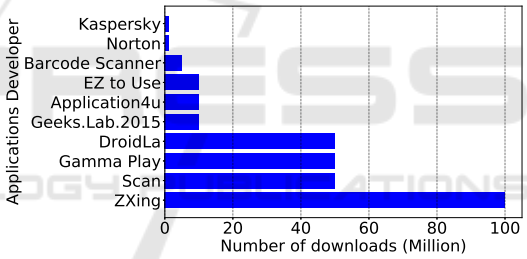

Figure 1: Popular QR code scanners.

ZXing Barcode Scanner (ZXing Team, 2017) is one of the most popular applications, with more than 100 million downloads. It is compatible with various 1D and 2D barcodes, displays the barcode type and retrieves additional information about URLs such as title and redirections. The ZXing library (GitHub, 2018) is a core Java source for multiple popular applications such as Barcode Scanner Pro (10M downloads) (Geeks.Lab.2015, 2018), and Barcode Scanner (Barcode Scanner, 2018) (5M downloads).

QR & Barcode Scanner by (Gamma Play, 2018) which recorded more than 50M downloads, and the free QR Scanners Bar Code Scanner & QR Code Reader (EZ to Use, 2018) recorded more than 10M downloads.

Figure 1 shows the tested applications that have more than one million downloads. Note that, being popular is not enough to be usable and secure, so we have investigated these applications also from privacy perspective.

Table 3: Crypto-based QR code scanners.

App Developer	Encryption	DS	Alg	KL (bits)	EncS	Str
(Madiff Net, 2017)	✓		N/A	48	Base64	N/A
(DroidLa, 2016)	✓		DES	56	Base64	Keyword
(Tengler, D., 2018)	✓		AES	128,192 & 256	Base64 & hex	N/A
(I-Plex Technology, 2018)	✓		N/A	N/A	Base64	N/A
(Ecrubit Consultancy Service, 2018)	✓		N/A	N/A	Base64	N/A

3.4 Save-privacy Applications

The applications we will illustrate in this section claim to protect the users' privacy, as they do not require access to personal information details. Obtaining permissions enables direct access to the information without users' interaction, which means easier and faster tasks. On the other hand, some applications may exploit these permissions and send user's private data to a third party (Krombholz et al., 2015).

A privacy-violating QR code scanner may access private images, videos, contacts, call history and user's location. Therefore, we need to balance the ease-of-use (getting the permissions) and protecting the users' privacy. Usually, minimal permissions include accessing the camera (to scan the barcode) and the network (if there is a need to check URLs). Obtaining other permissions can be extremely dangerous, and may result in information leakage attacks.

Red Dodo (Red Dodo, 2014) description says it does not require personal information details, by exploring the app's permissions list we have discovered that it has access to the storage, photos, Wi-Fi details, media and files.

Similarly, the QR Code Reader Extreme (FancyApp, 2018) claims to require few permissions, whereas by inspecting the app's permissions list we have found out that it has access to photos, media, files, storage network and camera.

Some applications offer QR code's online contents check (URLs), alongside with less permissions. An example is TeaCapps Scanner (TeaCapps, 2018), which requires camera and Internet permissions but not access to storage or files.

On the good side, Tokoware (Tokoware, 2016) a simple 1D and 2D barcode reader application, developed based on the ZXing (GitHub, 2018) library, and Lightning QR code Scanner (Application4u, 2018), require access to the camera and network, while QR Scanner (Privacy Friendly) (SECUSO Research Group, 2016) only requires access to the camera. Thus, all these applications are suitable for users who aim at protecting their privacy.

Since users' privacy is important, we have evaluated all the 28 tested barcode reader applications in terms of granted permissions. Table 4 shows the requested permissions for all our tested applications (i.e., Device & app history, Contacts, Location, Phone, Photos/media/files, Storage, Camera, Wi-Fi info, Device ID, Network).

4 DESIGN RECOMMENDATION

Based on our analysis for the available barcode readers, and based on suggestions provided in other works (Focardi et al., 2018b; Reeder et al., 2018) we present design tips for secure, usable, and privacy friendly barcode reader applications. The recommended design supports the reading of different barcode types, so to be used it in various contexts and prevents the execution of any encoded codes or commands. It is important to display the barcode type, in order to avoid wrong barcode type decoding. We should provide manuals for users to learn how to use secure reader applications. From the security side, we have to check any URL to avoid phishing and malware attacks, and use security warnings such as: browser warning against malicious URLs. Digital signature services can authenticate the barcode generator and guarantee data integrity, while encrypted contents can achieve confidentiality and access control.

Saving the users privacy is recommended by requesting minimum set of permissions to prevent accessing private files. The recommended permissions are camera (to scan the image) and Internet (to check URLs) only. Regarding usability, we recommend providing default basic functionalities with simple interface, so that non-expert users can use the app easily.

Based on these recommendations, we have implemented BarSec Driod (Heider Wahsheh, 2018), an Android mobile application that employs the ZXing library (GitHub, 2018), and follows our design tips to provide a secure barcode scanning service. The application design followed the JSON structure proposed by (Focardi et al., 2018b), and employed Java standard security libraries to implement the cryptographic primitives. The algorithms and key lengths were adopted based on (Focardi et al., 2018a). BarSec Driod specifications are included in Table 5.

Table 4: Permissions of tested QR Code readers.

App Developer	DevHis	Cont	Loc	Phn	Files	Stg	Cam	Wi-Fi	DevInfo	Net
(G Data Software AG, 2018)			✓		✓	✓	✓	✓		✓
(KasperSky Lab, 2018)				✓	✓	✓	✓	✓	✓	✓
(NortonMobile, 2016)				✓	✓	✓	✓		✓	✓
(Trend Micro, 2018)	✓				✓	✓	✓	✓		✓
(FANSec Lab Apps, 2018)	✓			✓	✓	✓	✓	✓	✓	✓
(Madiff Net, 2017)	✓	✓	✓	✓	✓	✓	✓	✓		✓
(Dennings, 2018)		✓	✓		✓	✓	✓			✓
(KidControl Dev, 2018)					✓	✓	✓			✓
(DroidLa, 2016)					✓	✓	✓			✓
(Tengler, D., 2018)		✓		✓	✓	✓	✓			
(Avira, 2018)				✓	✓	✓	✓	✓	✓	✓
(Browser Extension, 2018)					✓	✓	✓	✓		✓
(SECUSO Research Group, 2016)							✓			
(X and C Hi-Tech Inc, 2016)		✓	✓		✓	✓	✓	✓		✓
(iTechSol, 2018)							✓			✓
(Red Dodo, 2014)					✓	✓	✓	✓		✓
(Tokoware, 2016)							✓			✓
(FancyApp, 2018)					✓	✓	✓	✓		✓
(TeaCapps, 2018)							✓			✓
(Ecrubit Consultancy Service, 2018)					✓	✓	✓			✓
(Application4u, 2018)							✓			✓
(Scan, 2016)			✓		✓	✓	✓	✓		✓
(ZXing Team, 2017)	✓	✓		✓	✓	✓	✓	✓		✓
(Geeks.Lab.2015, 2018)	✓	✓			✓	✓	✓	✓		✓
(Gamma Play, 2018)							✓	✓		✓
(Barcode Scanner, 2018)	✓	✓			✓	✓	✓	✓		✓
(EZ to Use, 2018)	✓				✓	✓	✓			✓
(I-Plex Technology, 2018)		✓	✓		✓	✓	✓			✓

Table 5: BarSec Droid specification.

Feature	Supported	Key length (bits)
Encryption	AES[a]	128
Digital Signature	ECDSA[b]	256
	RSA	1,024
		2,048
		3,072
Encoding Scheme	ISO-8859-1	-
Structure	JSON	-
URL Checking	✓[c]	-
Compatibility	✓[d]	-

[a] Cipher Block Chaining (CBC), Output Feedback (OFB), Cipher Feedback (CFB) and Galois/Counter Mode (GCM);
[b] Elliptic Curve Digital Signature Algorithm (ECDSA);
[c] Norton safe web;
[d] Supports legacy QR code.

BarSec Droid can also read standard QR codes that do not include cryptographic data and not follow specific structures, by getting the full URL and checking their online content using Norton Safe Web service (Symantec Corporation, 2018).

5 USABILITY AND SECURITY EXPERIMENTS

We have conducted a users' survey to get the users' reactions about the BarSec Droid usage, and the level of trust for the provided security information. In order to compare the results with other security apps, we have chosen two very popular apps, KasperSky (KasperSky Lab, 2018) that belongs to the URL protection group, and QR Droid Private (DroidLa, 2016) that belongs to the Crypto-based protection group. We conducted our survey with the help of 30 users who were undergraduate students from different colleges (volunteers). They were asked to scan two QR codes for each reader (6 barcodes per user). Then, the users completed a survey that was built following the lines of (Gary Perlman, 2015), a very popular usability survey, and (Farb et al., 2013), a usability survey on secure mobile applications.

Our survey includes the following six points: Easy to use, time satisfaction, support information satisfaction, security of app, likely to use and visually appealing.

Table 6: T-test results for BarSec Droid vs. KasperSky.

	Easy to use	Time Satisfaction	Support info satisfaction	Security of app	Likely to use	Visually appealing
BarSec Droid	**4.0±0.2**	3.7±0.2	**3.9±0.2**	**4.6±0.1**	**3.6±0.1**	**3.6±0.2**
(KasperSky Lab, 2018)	3.4±0.1	3.8±0.2	2.3±0.2	3.8±0.2	3.0±0.2	2.2±0.2
p-value	0.001	0.895	0.000	0.000	0.012	0.000

Table 7: T-test results for BarSec Droid vs. QR Droid Private.

	Easy to use	Time Satisfaction	Support info satisfaction	Security of app	Likely to use	Visually appealing
BarSec Droid	**4.0±0.2**	3.7±0.2	**3.9±0.2**	**4.6±0.1**	3.6±0.1	3.6±0.2
(DroidLa, 2016)	3.3±0.2	3.4±0.2	3.1±0.2	1.9±0.2	**4.5±0.1**	3.8±0.2
p-value	0.002	0.169	0.004	0.000	0.000	0.393

Each point have five-point scale, described as: (1: very unsatisfied to 5: very satisfied). We have followed the answers evaluation method used on (Farb et al., 2013) by using paired T-test, which is a standard statistical method that compares the mean values of two groups. Paired T-test was used because the survey asked the user to evaluate 2 apps at a time.

Table 6 shows the Means (the value before ±), Mean Standard Error ((MSE), the value after ±), and p-value results from participants' feedback for BarSec Droid and KasperSky. Note that, in the T-Test, when the p-value is less than 0.05, there is a statistically significant difference between two groups (Limited, 2018), and in this case the mean and MSE values are marked in bold in the table. Table 7 shows the same results for BarSec Droid and QR Droid Private. According to Table 6, it is clear that the users' opinions recorded better results for BarSec Droid. For all questions the BarSec Droid means recorded higher values with statistical significance, except for the time of tasks satisfaction which recorded converged values (i.e., similar satisfaction).

According to Table 7, BarSec Droid recorded better answers for easiness of use, support information satisfaction and security trust. On the other hand, QR Droid Private recorded a higher level of being likely to use, which reflects the application excellent design and options. The time of tasks recorded converged values, which reflects that BarSec Droid, Kaspersky and QR Droid Private have acceptable time delay according to the users' feedback.

6 CONCLUSION

This study provides a comprehensive assessment for 28 barcode scanning applications, from security, usability and privacy perspectives. We have analyzed the features of these applications and classified them into four groups. Through the analysis, we have highlighted the limitations, and concluded that: Most of these apps do not cover the users' security and privacy needs. We proposed design tips for usable, secure and privacy-guaranteed barcode reader applications, and implemented BarSec Droid, a proof-of-concept Android app that utilizes other applications' advantages and resolves their weaknesses.

In order to evaluate our work, we have conducted a users' usability and security survey, for BarSec Droid and two popular QR code readers, i.e., KasperSky and QR Droid Private. The results show that when following the proposed design tips the user's security trust and awareness increases, as well as the ease of use. Adding to that, it will enhance the user's behavior towards the use of security applications. As a future work, we plan to extend our analysis to cover more applications, and evaluate the security techniques that check QR code contents such as: Google safe browsing and Norton Safe Web.

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